Technical Support Document for the Second Tier Analysis
Greater Wenatchee Regional Landfill
Landfill Expansion Project
Wenatchee, Washington
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1. EXECUTIVE SUMMARY

Proposed hydrogen sulfide and vinyl chloride emissions from proposed expansion of the Greater Wenatchee Regional Landfill (GWRL) exceed a regulatory trigger level called an Acceptable Source Impact Level (ASIL).

On the basis of the Second Tier Analysis described here and the modeled hydrogen sulfide and vinyl chloride concentrations, the Washington State Department of Ecology's Headquarters Office (Ecology) has determined the health risks are within the range that Ecology may approve for proposed new sources of Toxic Air Pollutants (TAP) under Chapter 173-460 Washington Administrative Code (WAC).

Below is the technical analysis performed by Ecology.

2. THE PROCESS

2.1 The Regulatory Process

The requirements for performing a toxics screening are established in Chapter 173-460 WAC. These rules require a review of any increase in toxic emissions for all new or modified stationary sources in the State of Washington.

2.1.1 The Three Tiers of Toxic Air Permitting

There are three levels of review when processing a new or modified emissions unit emitting TAPs: (1) Tier One (toxic screening), (2) Tier Two (health impacts assessment), and (3) Tier Three (risk management decision).

All projects are required to undergo a toxic screening (Tier One analysis) as required by WAC 173-460-040. The objective of the toxic screening is to establish the systematic control of new sources emitting toxic air pollutants in order to prevent air pollution, reduce emissions to the extent reasonably possible, and maintain such levels of air quality as will protect human health and safety. If modeled emissions exceed the trigger levels called ASILs, a Second Tier analysis is performed.

A Second Tier analysis, promulgated in WAC 173-460-090, is a site-specific health impacts assessment. The objective of a Second Tier analysis is to quantify the increase in lifetime cancer risk for persons exposed to the increased concentration of any Class A TAP and to quantify the increased health hazard from any Class B TAP in ambient air that would result from the proposed project. Once quantified, the cancer risk is compared to the maximum risk allowed by a Second Tier analysis, which is one in one hundred thousand, and the concentration of any Class B TAP that would result from the proposed project is compared to its effect threshold concentration.

If the emissions of a toxic pollutant result in a cancer risk of greater than one in one hundred thousand then an applicant may request Ecology perform a Tier Three analysis. A Tier Three is basically a risk management decision in which the Director of Ecology makes a decision that the risk of the project is acceptable based on determination that emissions will be maximally reduced through available preventive measures, assessment of environmental benefit, disclosure of risk at a public hearing and related factors associated with the facility and the surrounding community. Since Class B TAPs are not confirmed carcinogens, there is no Tier Three analysis performed. All risks are evaluated in the Tier Two analysis.

2.1.2 Processing Requirements

Ecology shall evaluate a source's Second Tier analysis only if:

- The authority (or in this case Ecology's Central Regional Office (CRO)) has advised Ecology that other conditions for processing the Notice of Construction (NOC) have been met,
- Emission controls contained in the conditional Notice of Construction represent at least Best Available Control Technology for Toxics (T-BACT), and
- Ambient concentrations exceed acceptable source impact levels after using more refined emission quantification and air dispersion modeling techniques.

Ecology's Central Regional Office (CRO) submitted the three items listed above to Ecology's Headquarters Office (Ecology) on October 5, 2007.

2.1.3 CRO's Activities

CRO received the application on February 1, 2006. Additional information was received May 12, 2006; May 15, 2006; July 25, 2006; October 5, 2006, and August 2, 2007. A preliminary draft Notice of Construction permit was shared with the applicant on September 7, 2007. On September 24, 2007, the applicant advised Ecology to "hold-off" on issuing the draft for public comment, as they were to revise their proposal. Subsequently, additional application information was received November 16, 2007; November 21, 2007, and December 26, 2007. CRO provided a new draft of the NOC to Ecology on January 4, 2008. Additional information was received by Ecology on March 7, 2008.

2.2 T-BACT Verification

T-BACT is required for any new or modified emission unit that has an increase in emissions of toxic air pollutants.

2.2.1 Ambient Concentration of Toxic Air Pollutants

Ecology reviewed the application and verified the emission estimates. Emissions of hydrogen sulfide and vinyl chloride exceed the ASILs and a Second Tier analysis must be performed.

3. THE PROJECT

3.1 Permitting History

- On April 2, 1999, Ecology issued Air Operating Permit (AOP) No. DE 99AOP-C122. It underwent several revisions during it's five year term, expiring on April 2, 2004.

- On March 8, 2004, Ecology issued renewal AOP No. 04AQ-C007. It was revised on April 13, 2006, and March 7, 2008, and will expire on April 2, 2009, or upon issuance of a subsequent revision.

- Trench 1 and the northeast half of the North Berm were capped during the summer 2000, resulting in issuance of the first Notice of Construction (air quality permit) to this source. Closure of these cells was permitted under NOC Order No. 00AQCR-1000, issued April 21, 2000.

- On January 29, 2003, NOC Order No. 00AQCR-1000 First Revision was issued. The revised Order mandated installation and use of an active landfill gas collection system and a single enclosed flare.

- On April 13, 2006, NOC Order No. 00AQCR-1000 Second Revision was issued. The revised Order allowed installation of additional landfill gas flaring capacity, provided that all flaring capacity is achieved through the use of enclosed flares meeting Best Available Control Technology.

- On March 7, 2008, NOC Order No. 00AQCR-1000 Third Revision was issued. The revised Order allowed for an increase in the flare's sulfur dioxide emission rate.

3.2 The Proposed Project

GWRL has proposed to expand their existing municipal solid waste landfill to accommodate future demands for landfill capacity in the region. The existing landfill does not have sufficient capacity to meet the projected future needs of the region for environmentally safe and cost effective solid waste disposal. The proposal is to increase the landfill's disposal capacity by approximately 34,278,000 cubic yards (92.5 acres).

GWRL also proposes to periodically operate a portable rock crusher and soil screening unit. The rock crushing and soil screening operations would be used to enhance recycling and use of concrete, asphalt, and excavated and imported soils delivered to the landfill.

Landfill gas is collected with an active collection system. The collection system is currently routed to a single enclosed flare. Additional flare(s) may be installed up to a total flare capacity of 2000 standard cubic feet per minute.

In addition, GWRL intends to make several other changes that will not effect the emissions of hydrogen sulfide or vinyl chloride. Those changes are:

- Relocation of the Wenatchee Red Apple Fliers' facility.
- Development of landfill accessory facilities such as scales, scale house, maintenance facility, new entrance, and new site roads.
- Development of integrated solid waste handling improvements, including a material recovery facility.
- Use of a portable rock, concrete, and asphalt crusher and soil screening unit.
- Potential future relocation of solid waste collection company and administrative services.

3.3 Site Description

The landfill is located at 191 S. Webb Avenue, Douglass County near Wenatchee, Washington.

3.4 Emissions

GWRL has estimated its emissions from the project and they are compared to the Small Quantity Emission Rate Tables (SQER) below:

Pollutant	Class A or B Pollutant	Landfill Expansion		SQER		Emissions Above SQER Yes or No
		Lb/hr	Lb/yr	Lb/hr	Lb/yr	
1,1,1, Trichloroethane	B	0.0059	51.8	5.0	43,748	No
1,1,2,2-Tetrachloroethane	B	0.017	149.5	0.2	1,750	No
1,1-Dichloroethane	B	0.0011	9.5	5.0	43,748	No
1,1-Dichloroethene	B	0.0019	16.6	1.2	10,500	No
1,2-Dichloroethane	A	0.0017	14.6	-	10	Yes
Isopropyl alcohol	B	0.0080	70	5.0	43,748	No
1,2-Dichloropropane	A	0.0019	16.5	-	500	No
Acetone	B	0.039	343.2	5.0	43,748	No
Acrylonitrile	A	0.00073	6.4	-	10	No
Benzene	A	0.0038	33	-	20	Yes
Butane	B	0.049	426.9	5.0	43,748	No
Carbon disulfide	B	0.0041	35.7	2.0	17,500	No
Carbon tetrachloride	A	0.000057	0.5	-	20	No
Carbonyl sulfide	B	0.0000211	0.0185	-	-	Yes
Chlorobenzene	B	0.00036	3.24	2.6	22,750	No
Chlorodifluoromethane	B	0.0104	90.9	5.0	43,748	No
Ethyl chloride	B	0.0040	35.2	5.0	43,748	No
Chloroform	A	0.00033	2.9	-	10	No
Chloromethane	B	0.000101	0.89	5.0	43,748	No
Dichlorobenzene	B	0.000029	0.26	5.0	43,748	No
Dichlorodifluoromethane	B	0.17	1,529.2	5.0	43,748	No
Dichlorofluoromethane	B	0.025	216.4	2.6	22,750	No
Dichloromethane	A	0.0023	20.5	-	50	No
Ethyl mercaptan	B	0.013	115.6	0.02	175	No
Ethyl benzene	B	0.019	168.6	5.0	43,748	No
Ethylene dibromide	A	0.000017	0.15	-	0.5	No
Formaldehyde	A	0.0078	68.3	-	20	Yes
Hexane	B	0.205	1,792.9	2.6	22,750	No
Hydrogen sulfide	B	0.942	8202	0.02	175	Yes
Mercury	B	9.7×10^{-8}	0.0009	-	50	No
Methyl ethyl ketone	B	0.072	633.9	5.0	43,748	No
Methyl isobutyl ketone	B	0.0037	32.7	5.0	43,748	No
Methyl mercaptan	B	0.011	97.3	0.02	175	No
Napthalene	B	0.00063	0.56	2.6	22,750	No
Polyaromatic hydrocarbon	A	9.16×10^{-6}	0.080	-	-	Yes
Pentane	B	0.022	192.6	5.0	43,748	No
Perchloroethylene	A	0.0062	54.2	-	500	No
Toluene	B	0.083	726.4	5.0	43,748	No
Trichloroethylene	A	0.0028	24.2	-	50	No
Vinyl chloride	A	0.0072	62.8	-	20	Yes
Xylenes	B	0.055	483.8	5.0	43,748	No
Styrene	B	0.0014	12.2	5.0	43,748	No
Trimethyl benzene	B	0.0066	58.2	5.0	43,748	No
1,2-Dichloroethene	B	0.00070	6.1	-	50	No
1,2 dichloro- 1,1,2,2 tetrafluoroethane	B	0.0012	10.9	5.0	43,748	No

Emissions of 1,2-dichloroethane, benzene, carbonyl sulfide, formaldehyde, hydrogen sulfide, polyaromatic hydrocarbon, and vinyl chloride exceed the values listed in SQER tables.

3.4.1 Point of Compliance

Assessment of potential health risks from the project were based on the maximum modeled concentration of 1,2-dichloroethane, benzene, carbonyl sulfide, formaldehyde, hydrogen sulfide, polyaromatic hydrocarbon, and vinyl chloride at an assumed point of public exposure (nearest point of ambient air) the property fence line. The maximum concentration is assumed to be at the property fence line and the distance to the nearest residence 406 feet (124 meters).

3.4.1.1 Emissions Concentrations

Below are the modeling results of the pollutants that exceeded the SQER's compared to the ASILs.

Pollutant	Class A or Class B TAP?	Highest Concentration (Fence line) ($\mu g/m^3$)	ASIL ($\mu g/m^3$)	Emissions Above ASIL Yes or No
1,2-Dichloroethane	A	0.005	0.0380000 (annual avg.)	No
Benzene	A	0.011	0.12 (annual avg.)	No
Carbonyl sulfide	B	N/A	---[1]	No
Formaldehyde	A	0.0007	0.0770000 (annual avg.)	No
Hydrogen sulfide	B	1.79	0.9 (24-hr avg.)	Yes
Polyaromatic hydrocarbon	A	1.1×10^{-6}	0.00048 (annual avg.)	No
Vinyl chloride	A	0.023	0.0120000 (annual avg.)	Yes

3.4.2 Pollutants Subject to Second Tier Analysis

Emissions of 1,2-dichloroethane, benzene, formaldehyde, and polyaromatic hydrocarbon are below the ASIL after being modeled and carbonyl sulfide has no listed ASIL therefore only hydrogen sulfide and vinyl chloride are subject to review under this Second Tier analysis.

3.4.2.1 Background Emissions

Information on existing ambient air quality TAP concentrations of vinyl chloride and hydrogen sulfide near the GWLF has been researched and obtained from readily available sources, and are discussed as follows:

[1] There is no ASIL for carbonyl sulfide. This TAP is not analyzed further.

There are five other documented sources of vinyl chloride in Chelan and Douglas Counties, Washington. These sources include four other landfills and one demolition waste facility. The reported emissions for these five sources range from 3.97 to 74.6 pounds per year (based on data for 1999—the most recent information available). However, as the closest source is approximately 10 miles from the GWLF, the ambient air concentration is estimated to be below 0.0001 μg/m^3 for the receptors situated near the GWLF, due to air dispersion characteristics.

Facility Name	Emissions (lbs/yr)	Address	Approximate Distance from GWLF
Box Canyon Inert Demolition Waste Facility	74.6	4801 Contractors Drive, E. Wenatchee, WA 98802	10 miles to the northwest
Cashmere Landfill	17.9	101 Woodring St, Cashmere, WA 98815	17 miles to the northwest
Manson Landfill	4.93	Manson, Chelan Co., WA	31 miles to the north
Dryden Landfill	3.97	9073 Highway 2, Dryden, WA	22 miles to the northwest
Pine Canyon Landfill	6.49	Near Jameson Lake, Douglas County, WA	30 miles to the northeast

There were no emissions data readily available for hydrogen sulfide. As the ambient air quality TAP concentrations for vinyl chloride are expected to be toxicologically insignificant (due to the large distance from the other sources to the GWRL), they have not been added to the modeled TAP concentrations at the fence line of the proposed expansion of the GWRL, or to the modeled TAP concentrations at the nearby residences.

3.4.3 T-BACT

T-BACT is contained in the existing flare NOC Order No. 00AQCR-1000 Second Revision, and consists of (1) an active landfill gas collection system, with 90% collection efficiency, and (2) landfill gas control by an enclosed flare with 99% destruction of TAPs. Many of the conditions in the proposed decision are BACT/T-BACT for a particular activity. Ecology concurs with CRO’s T-BACT.

3.4.4 Air Dispersion Modeling

The air quality dispersion model used for this project was EPA’s Industrial Source Complex (ISC3) model with meteorological data processed from the Pangborn Memorial Airport in Wenatchee. Five years of meteorological data were from 2000 through 2004. Typical meteorological conditions at the landfill include the prevailing wind direction to the southeast and an annual average wind speed of 7.8 miles per hour.

Ecology no longer accepts projects using ISC3 as of December 2006. We are, however, willing to allow this project to continue using ISC3 (a functionally equivalent model) for this one last project. In November, Mr. Laurence Reider (Chambers Group), sent a letter to Mr. Eric Sonsthagen (SCS Engineers) discussing a comparison of ISC3 to AERMOD. A copy of that letter was forwarded to Ecology. The conclusion of that letter is that AERMOD is a more complicated model and is believed to more closely represent actual conditions. It also states that typically a less representative or less accurate model results in a more conservative (higher) result and that AERMOD is believed to yield lower more realistic results. For this project, emissions from the flare would be considered a short stack and that the results from AERMOD would be expected to be similar to those of ISC3.

4. GENERIC HEALTH IMPACTS ASSESSMENT PROCESS

A health impacts assessment was prepared by the applicant and was reviewed and approved by Ecology. A team was assigned to this project consisting of an engineer, a toxicologist, and a modeler.

Below are descriptions of the content of each part of the Health Impacts Assessment:

4.1 Hazard Identification

Hazard identification involves gathering and evaluating toxicity data on the types of health injury or disease that may be produced by a chemical and on the conditions of exposure under which injury or disease is produced. It may also involve characterization of the behavior of a chemical within the body and the interactions it undergoes with organs, cells, or even parts of cells. This information may be of value in determining whether the forms of toxicity known to be produced by a chemical agent in one population group or in experimental settings are also likely to be produced in human population groups of interest. Note: Risk is not assessed at this stage; hazard identification is conducted to determine whether and to what degree it is scientifically correct to infer that toxic effects observed in one setting will occur in other settings (i.e., are chemicals found to be carcinogenic or teratogenic in experimental animals also likely to be so in adequately exposed humans?).

4.1.1 Identification of Potentially Exposed Populations

This step involves describing the nature and size of the various populations exposed to a chemical agent in the vicinity of the proposed project.

4.1.2 Discussion of TAP Concentrations

This step involves the identification of the toxicological profiles of all toxic air pollutants that exceed the ASIL. It includes a discussion of the toxicological effects of hazardous substances, chemicals, and compounds. Each profile includes an examination, summary, and interpretation of available toxicological and epidemiological data evaluations on the hazardous substance.

4.1.3 Exposure Assessment

This step includes characterization of exposure pathways, and total daily intake based on the magnitude and duration of exposure to toxic air pollutants that exceed the ASIL from these pathways. The evaluation could include past exposures, current exposures, or exposures expected in the future.

4.1.4 Risk/Hazard Assessment

This step involves the integration of data analyses from each step of the risk assessment to determine the likelihood that the human population of interest will experience any of the various forms of toxicity associated with a chemical under its known or anticipated conditions of exposure.

4.1.5 Uncertainty

In almost all risk assessments undertaken in support of regulatory decisions, especially concerning chronic hazards, risk assessors are required to go beyond available data and make inferences about risks expected for conditions of exposure under which direct evidence of risk cannot now be collected. When scientific uncertainty is encountered in a risk assessment, the integration of any assumptions is required to fill information gaps. The following are examples of components that constitute gaps in the scientific basis for assessing human cancer risk:

- How relevant is the data to humans?
- How relevant to humans are results from animal studies using a different route of exposure?
- How relevant are results from studies using an exposure regimen (in terms of frequency and duration) that differs from the human situation?
- Which species/strains of animals are most appropriate for dose response assessment in humans?
- How should risk estimates be developed?
- Using most sensitive species/strain/sex?
- Combining incidents of benign and malignant tumors?
- Using pooled tumor incidence (tumor bearing animals)?
- Can results of an animal study that does not extend over a lifetime be extrapolated to lifetime?
- How does the dose-response relation relate to the unobservable dose-response relation in the dose region of concern for the human population under study?
- How should low-dose risk be modeled?
- Do agents operate by threshold or non-threshold mechanisms?

5. HEALTH IMPACTS ASSESSMENT

5.1 Introduction

The Second Tier analysis described below was conducted according to the requirements promulgated in Chapter 173-460 WAC. It addressed the public health risk associated with exposure to hydrogen sulfide and vinyl chloride emissions from landfill operations in the health effects assessment prepared by the consultant (SCS Engineers) for the Greater Wenatchee Regional Landfill.

5.2 Hazard Identification

There are two TAPs being evaluated in this analysis. They are hydrogen sulfide and vinyl chloride. Hydrogen sulfide, CAS # (7783-06-4) is a colorless gas with a strong odor of rotten eggs. Its molecular weight is 34 with a boiling point of -76 ^{0}F. Vinyl chloride, CAS # (75-01-4) is a colorless gas that liquefies in a freezing mixture. It is slightly soluble and has a molecular weight of 62.5. Vinyl chloride has a boiling point is 7 ^{0}F.

5.2.1 Acute Effects

5.2.1.1 Hydrogen Sulfide

Some epidemiologic studies have reported compromised cognitive and sensory performance, and physiological effects, such as nausea and headache, among individuals exposed to low concentrations of hydrogen sulfide.

5.2.1.2 Vinyl Chloride

Acute (short-term) exposure to high levels of vinyl chloride in air has resulted in central nervous system effects. The exposure has the potential to manifest itself as:

- Acute exposure of humans to high levels via inhalation has resulted in effects on the CNS, such as dizziness, drowsiness, headaches, and giddiness.
- Slight irritation to the eyes and respiratory tract in humans.
- Acute exposure to extremely high levels has caused loss of consciousness, lung, and kidney irritation, and inhibition of blood clotting in humans and cardiac arrhythmias in animals.

5.2.2 Chronic Effects

5.2.2.1 Hydrogen Sulfide

Epidemiological information for specific chronic effects in humans include significant impairments of reaction time, balance, color discrimination, memory and other cognitive abilities, as well as effects on mood (Kilburn & Warshaw, 1995).[2]

5.2.2.2 Vinyl Chloride

Cancer is a major concern from exposure to vinyl chloride via inhalation, as vinyl chloride exposure has been shown to increase the risk of a rare form of liver cancer in humans. EPA has classified vinyl chloride as a Group A, human carcinogen.[3] In addition to the following effects:

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[2] Kilburn KH, Warshaw RH. (1995) Hydrogen sulfide and reduced-sulfur gases adversely affect neurophysiological functions. Toxicol Ind Health.; 11(2):185-97.

[3] http://www.epa.gov/ttn/atw/hlthef/vinylchl.html

- Chronic (long-term) exposure to vinyl chloride through inhalation and oral exposure in humans has resulted in liver damage.

- A small percentage of individuals occupationally exposed to high levels of vinyl chloride in air have developed a set of symptoms termed "vinyl chloride disease," which is characterized by Raynaud's phenomenon (fingers blanch and numbness and discomfort are experienced upon exposure to the cold), changes in the bones at the end of the fingers, joint and muscle pain, and scleroderma-like skin changes (thickening of the skin, decreased elasticity, and slight edema).

- Central nervous system effects (including dizziness, drowsiness, fatigue, headache, visual and/or hearing disturbances, memory loss, and sleep disturbances) as well as peripheral nervous system symptoms (peripheral neuropathy, tingling, numbness, weakness, and pain in fingers) have also been reported in workers exposed to vinyl chloride.

- Animal studies have reported effects on the liver, kidney, and CNS from chronic exposure to vinyl chloride.

- EPA has established a Reference Concentration (RfC) of 0.1 milligrams per cubic meter, and a Reference Dose (RfD) of 0.003 milligrams per kilogram per day for vinyl chloride.

5.2.3 Reproductive/Developmental Effects

5.2.3.1 Hydrogen Sulfide

Although a single generation reproductive study (Dorman et al., 2000) noted testicular alterations that were observed only in the high dose group, the alterations were not significantly different from the controls and had no apparent effects on reproductive performance. No other indicators of reproductive toxicity were observed in this study. No significant histopathology of reproductive organs was noted in a longer duration (subchronic) study. These results can be considered to lessen the concern for lack of a multi-generational reproductive study.[4]

5.2.3.2 Vinyl Chloride

The following information was identified with respect to vinyl chloride emissions:

- Several case reports suggest that male sexual performance may be affected by vinyl chloride. However, these studies are limited by lack of quantitative exposure information and possible co-occurring exposure to other chemicals.

- Several epidemiological studies have reported an association between vinyl chloride exposure in pregnant women and an increased incidence of birth defects, while other studies have not reported similar findings.

[4] http://www.epa.gov/IRIS/subst/0061.htm

- Epidemiological studies have suggested an association between men occupationally exposed to vinyl chloride and miscarriages in their wives' pregnancies although other studies have not supported these findings.

- Testicular damage and decreased male fertility have been reported in rats exposed to low levels for up to 12 months.

- Animal studies have reported decreased fetal weight and birth defects at levels that are also toxic to maternal animals in the offspring of rats exposed to vinyl chloride through inhalation.

5.2.4 Cancer Risk

5.2.4.1 Hydrogen Sulfide

Hydrogen sulfide has not been shown to cause cancer in humans, and its possible ability to cause cancer in animals has not been studied thoroughly. The Department of Health and Human Services, the International Agency for Research on Cancer (IARC), and the EPA have not classified hydrogen sulfide for carcinogenicity.[5]

5.2.4.2 Vinyl Chloride

EPA has classified vinyl chloride as a Group A, a human carcinogen. Some of the effects include:

- Inhaled vinyl chloride has been shown to increase the risk of a rare form of liver cancer (angiosarcoma of the liver) in humans.

- Animal studies have shown that vinyl chloride, via inhalation, increases the incidence of angiosarcoma of the liver and cancer of the liver.

- Several rat studies show a pronounced early-life susceptibility to the carcinogenic effect of vinyl chloride (i.e., early exposures are associated with higher liver cancer incidence than similar or much longer exposures that occur after maturity).

- EPA uses mathematical models, based on animal studies, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of a chemical. EPA has calculated an inhalation unit risk estimate of 8.8×10^{-6} $(\mu g/m^3)^{-1}$ for lifetime exposure to vinyl chloride. Please see IRIS for current information.

- EPA has calculated an oral cancer slope factor of 1.5 $(mg/kg/d)^{-1}$ for lifetime exposure to vinyl chloride.

[5] http://www.atsdr.cdc.gov/tfacts114.pdf

5.2.5 Terrestrial Fate

5.2.5.1 Hydrogen Sulfide

Hydrogen sulfide does not appear to create a risk from terrestrial deposition. A literature search did not produce any information on terrestrial fate.

5.2.5.2 Vinyl Chloride

If vinyl chloride is released to soil, it will be subject to rapid volatilization based on a reported vapor pressure of 2660 mm Hg at 25 deg C; half-lives of 0.2 and 0.5 days were reported for volatilization from soil incorporated into 1 and 10 cm of oil, respectively. Any vinyl chloride, which does not evaporate, will be expected to be highly mobile in soil. It may be subject to biodegradation under anaerobic conditions such as exists in flooded soil and groundwater; however, limited existing data indicate that vinyl chloride is resistant to biodegradation in aerobic systems and therefore it may not be subject to biodegradation in natural waters. It will not be expected to hydrolyze in soils under normal environmental conditions.[6]

5.3 Aquatic Fate

5.3.1 Hydrogen Sulfide

Hydrogen sulfide does not appear to create a risk from aquatic fallout. A literature search did not produce any information on aquatic fate.

5.3.2 Vinyl Chloride

If vinyl chloride is released to water, it will not be expected to hydrolyze, to bioconcentrate in aquatic organisms or to adsorb to sediments. It will be subject to rapid volatilization with an estimated half-life of 0.805 hr for evaporation from a river 1 m deep with a current of 3 m/sec and a wind velocity of 3 m/sec(1,SRC). In waters, containing photosensitizers such as humic acid, photodegradation will occur rapidly. Limited existing data indicate that vinyl chloride is resistant to biodegradation in aerobic systems and therefore, it may not be subject to biodegradation in natural waters.

5.4 Atmospheric Fate

5.4.1 Hydrogen Sulfide

Atmospheric hydrogen sulfide is affected by ambient temperature and other atmospheric variables including humidity, sunshine, and presence of other pollutants. The decreased temperatures and decreased levels of hydroxide in northern regions (e.g. Alberta, Canada) in winter increase the residence time of H_2S in air. Once released into the atmosphere, hydrogen sulfide will behave like many other gaseous pollutants and be dispersed and eventually removed.

[6] http://www.speclab.com/compound/c75014.htm

Residence times in the atmosphere range from about one day to more than 40 days, depending upon season, latitude, and atmospheric conditions.[7]

5.4.2 Vinyl Chloride

If vinyl chloride is released in the atmosphere, it can be expected to exist mainly in the vapor-phase in the ambient atmosphere based on a reported vapor pressure of 2660 mm Hg at 25 deg C. Gas phase vinyl chloride is expected to degrade rapidly in air by reaction with photochemically produced hydroxyl radicals with an estimated half-life of 1.5 days. Products of reaction in the atmosphere includes chloroacetaldehyde, HCl, chloroethylene epoxide, formaldehyde, formyl chloride, formic acid, and carbon monoxide. In the presence of nitrogen oxides, eg photochemical smog situations, the half-life would be reduced to a few hours.[8]

5.5 Identification of Exposed Populations

The table below shows the distances to the sensitive receptors, businesses, and residences.

#	Name	Address	Facility type	Distance in feet	Distance in meters
Nearest Sensitive Receptors					
1	Rock Island School	5645 Rock Island Rd. Rock Island	School (K-5)	7,350	2,240
2	Grand School	1430 1st St. SE East Wenatchee	School (K-5)	19,391	5,910
3	Kenroy School	601 N. Jonathan Ave. East Wenatchee	School (K-5)	20, 952	6,386
4	Sterling Middle School	East Wenatchee	School (6-7)	21,975	6,698
5	Life's Little Pleasures	516 N. Lyle Ave. East Wenatchee	Assisted Living Facility	17,645	5,378
6	Lover & Wishes Adult Family Home	325 N. Kansas Ave. East Wenatchee	Retired Community	19,253	5,868
7	Quality Care Homes	208 S. Houston Ave. East Wenatchee	Retired Community	21,644	6,597
8	Highline Care Center	609 Highline Dr. East Wenatchee	Retired Community/hospital	22,388	6,824
9	Epic Wenatchee Early Childhood Developmental Program Apple Valley Site	1901 Rock Island Rd. East Wenatchee	Day Care	18,198	5,547
10	Teddy Bear Child	1301 3rd St. SE	Day Care	20,104	6.128

[7] http://www.gasdetection.com/TECH/h2s.html
[8] http://www.speclab.com/compound/c75014.htm

#	Name	Address	Facility type	Distance in feet	Distance in meters
	Care Pre-School	East Wenatchee			
11	Sandra K Root Daycare	3064 Riviera Blvd. Malaga	Day Care	16,041	4,889
Nearest Business Address					
I	Jen Tel Pest Management Inc	4084 Airport Way East Wenatchee	Pest Manager	4,859	1,481
II	Century Aviation	3908 Airport Way East Wenatchee	Plane Restoration	5,140	1,567
III	Wings of Wenatchee	3724 Airport Way East Wenatchee	Flight school	5,569	1,687
IV	Martin & Webber Plumbing	1010 Webb Pl. S. East Wenatchee	Plumber	3,046	928

Nearest Residential Addresses				
Address		Facility type	Distance in feet	Distance in meters
A	488 S. Webb Ave, East Wenatchee	Residence	406	124
B	4920 4th St. SE, East Wenatchee	Residence	430	131
C	5361 & 5371 4th St. SE, East Wenatchee	Residence	430	131
D	5451 4th St. SE, East Wenatchee	Residence	524	160
E	275 Witte Ave, East Wenatchee	Residence	562	171
F	310 Woodridge Ave. East Wenatchee	Residence	1,137	347
G	277 S. Ward Ave, East Wenatchee	Residence	1,106	337
H	11 S Ward, East Wenatchee	Residence	1,008	307

5.6 Discussion of TAP Concentrations

As shown above, the concentrations of hydrogen sulfide and vinyl chloride at the closest point of ambient air, the highest concentration, and the nearest receptor are:

Pollutant	Class A or B TAP	Closest Point of Ambient Air (fence line) (μg/m^3)	Highest Concentration (fence line m) (μg/m^3)	Residence (171 m) (μg/m^3)	ASIL (μg/m^3)
Hydrogen Sulfide	B	Same as highest concentration	46.7 24-hr avg.	16.16 Residence E	0.9 24-hr avg.
Vinyl Chloride	A	Same as highest concentration	0.022 Annual Average	0.0044 Residence E	0.0120000 Annual Average

5.7 Background

Background ambient levels of H_2S in urban areas range from 0.11 to 0.33 ppb, while in undeveloped areas concentrations can be as low as 0.02 to 0.07 ppb (ATSDR 2004).[9]

The 1999 NATA (EPA, 2005) states the HAPEM5 modeled background vinyl chloride concentration in each of Douglas County's census tracts was 0.021682-µg/m^3.

5.7.1 Exposure Assessment (daily intake and risk)

5.7.1.1 Hydrogen Sulfide

Due to the high vapor pressure of H_2S, all the landfill's emissions are likely to be remain in the air, thus all resulting exposure is likely to be by inhalation alone.

5.7.1.2 Vinyl Chloride

No significant transfer of vinyl chloride from air to ground water is expected; therefore, nearly all exposure resulting from landfill emissions is expected to be by inhalation.

6. RISK/HAZARD ASSESSMENT

6.1 Hydrogen Sulfide

It appears hydrogen sulfide emissions will not disperse enough to prevent people from experiencing strong unpleasant odors and health problems at times at the residences nearest the landfill.

	Residence D	Residence E	Residence F
1-hr TWA (µg/m^3)	31.4	40.4	37.1
24-hr TWA (µg/m^3)	< 1.79	< 1.79	< 1.79

The Risk-Based Concentration (RBC) levels used in Second Tier analysis are based on existing data. Ecology evaluated these data and developed the following exposure limits:

RBC (µg/m^3)	Hours	Basis
42	1	1-hr Reference exposure limit for H_2S
2	24	24-hr Reference exposure limit for H_2S

[9] Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological profile for hydrogen sulfide (*Draft for Public Comment*). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Chapter 2, p.1.

6.1.1 Hazard Quotient

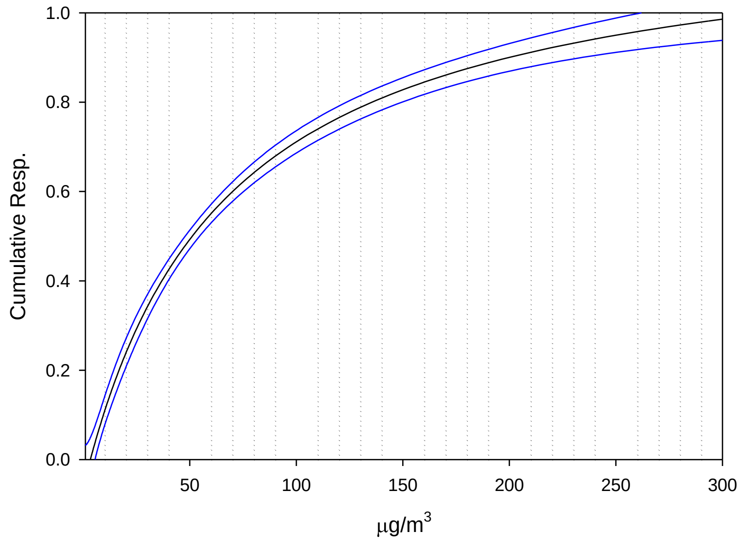
The ratio of the potential exposure to the substance and the level at which no adverse effects are expected. If the hazard quotient (HQ) is calculated to be less than one, then no adverse health effects are expected as a result of exposure. If the HQ is greater than one, then adverse health effects are possible. The HQ cannot be translated to a probability that adverse health effects will occur, and is unlikely to be proportional to risk. It is especially important to note that a HQ exceeding one does not necessarily mean that adverse effects will occur.

Averaging Time Exposure Duration	Closest Point of Ambient Air (fence line) (µg/m^3)	Highest Concentration (fence line m) (µg/m^3)	Residence (171 m) (µg/m^3)
24-Hr Concentration (ug/m^3)	1.79	< 1.79	< 1.79
24-Hr Exposure Limit (ug/m^3)	2	2	2
24-Hr HQ	0.90	0.90	0.90
1-Hr Concentration (ug/m^3)	42	31.4	40.4
1-Hr Exposure Limit (ug/m^3)	42	42	42
1-Hr HQ	1	0.75	0.96

The HIA is silent on the exact concentrations of hydrogen sulfide at residences A, B, and C. Based upon the gradient maps in the application, the concentrations at those residences are lower than the maximum of 1.79 µg/m^3 and 40.4 µg/m3 listed for 1-hr and 24-hr concentrations, respectively. The risk is therefore assumed acceptable.

Assuming these H_2S concentrations provided by SCS Engineers are those expected under worst-case conditions, the AQP toxicologist predicts:

- 36% to 42% of people at the residences may experience health impacts occasionally since the levels predicted have been reported to cause portions of the general human population to experience rotten egg odor and neurophysiological abnormalities in reaction time, color discrimination, and mood. The cumulative response for each concentration listed in the figure (below).



- During hours with unfavorable dispersion by wind, H_2S concentrations reaching residences D, E, and F may occasionally cause some people present at these locations to experience neurophysiological abnormalities in reaction time, color discrimination, and mood. On days with unfavorable dispersion by wind, people at these residences may experience physiological effects from H_2S exposure, such as nausea and headache. Exposure to ambient air containing H_2S at these levels resulted in elevated self-reported health symptoms - especially those related to the central nervous system.

6.2 Vinyl Chloride

The formula for determining risk is as follows: Risk = C_{Air} x URF

Where C_{Air} is Concentration in air at the receptor (µg/m^3).
And, URF is Unit Risk Factor for vinyl chloride (8.8 x10^{-6} (µg/m^3)). This factor comes from the EPA's Technology Transfer Network.[10]

Location	Distance (meters)	C_{Air} (µg/m^3)	URF[11] (µg/m^3)	Risk (µg/m^3)
Point of closest ambient air	Fence Line	0.023	8.8 x10^{-6}	1.94 x 10^{-7}
Point of maximum concentration	Fence Line	0.023	8.8 x10^{-6}	1.94 x 10^{-7}
Point of closest residential receptor	124	0.0044	8.8 x10^{-6}	3.87 x 10^{-8}

[10] http://www.epa.gov/ttn/atw/hlthef/vinylchl.html#ref1
[11] Background is 0.451-µg/m^3. Using this background the risk from background alone is 5.9x10^{-6}.

- It appears the vinyl chloride emissions will disperse enough that they will not cause additional cancer risk above de minimis levels at the residences nearest to the landfill.

- Vinyl chloride emissions will not be present at levels high enough to cause non-cancer health hazards either.

6.3 Uncertainty Characterization

The database of hydrogen sulfide effects in humans and animals is extraordinarily extensive; therefore, the AQP toxicologist has high confidence there will be harmful effects among people exposed at the levels stated by SCS.

Vinyl chloride is a known human carcinogen. Its toxicity has been characterized by several large occupational epidemiology studies and by numerous animal studies; therefore, the AQP toxicologist has high confidence vinyl chloride will not harm people exposed at the levels stated by SCS.

Not all of the receptor locations in the neighborhood of the landfill, as identified by SCS, were adequately characterized in terms of modeled concentrations. Therefore, this health risk assessment could not be completed.

6.4 Length of Exposure

People offsite who approach the landfill's fence line from downwind may occasionally experience transient neurological and physiological harm from landfill H_2S emissions. People at residences E, F, and G may occasionally experience transient neurological and physiological reactions to H_2S exposure. Exposure the vinyl chloride from the landfill is not likely to cause harm to anyone.

7. CONCLUSION

The project will not have a significant adverse impact on air quality. The Washington State Department of Ecology finds that the applicant, the Greater Wenatchee Regional Landfill, has satisfied all requirements for Second Tier analysis.

For additional information, please contact:

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8. LIST OF ABBREVIATIONS

AEMOD	Air dispersion model
AOP	Air Operating Permit as described in Chapter-173-401 WAC
ASIL	Acceptable Source Impact Level
CRO	Washington State Department of Ecology, Central Regional Office
Ecology	Washington State Department of Ecology, Headquarters Office
GWRL	Greater Wenatchee Regional Landfill
HQ	Hazard Quotient
IARC	International Agency for Research on Cancer
ISC3	Industrial Source Complex 3
SQER	Small Quaintly Emission Rate
NOC	Notice of construction as defined in chapters 173-400 & 460 WAC
TAP	Toxic Air Pollutants
T-BACT	Best Available Control Technology for Toxics
WAC	Washington Administrative Code